Ex.No: 09	Database Normalization
Date: 18.10.23	

Aim:

To normalize the table for a given application.

Descriptions:

Database Normalization is a technique that helps in designing the schema of the database in an optimal manner. The normalization process is used to reduce the redundancy in a relation or set of relations. Anomalies in insertion, deletion, and update which can be caused by relation redundancy can be avoided by normalization. The process is incremental, and higher degrees of database normalization cannot be performed until the preceding levels are met.

There are the four types of normal forms:

Normal Form	Description
1NF	A relation is in 1NF if it contains an atomic value.
2NF	A relation will be in 2NF if it is in 1NF and all non-key attributes are fully functional dependent on the primary key.
3NF	A relation will be in 3NF if it is in 2NF and no transition dependency exists.
4NF	A relation will be in 4NF if it is in Boyce Codd normal form and has no multivalued dependency.
5NF	A relation is in 5NF if it is in 4NF and does not contain any join dependency and joining should be lossless.

First Normal Form (1NF)

- A relation will be 1NF if it contains an atomic value.
- It states that an attribute of a table cannot hold multiple values. It must hold only single-valued attributes.
- First normal form disallows the multi-valued attribute, composite attribute, and their combinations.

Instructor's name	Course code
Prof. George	(CS101, CS154)
Prof. Atkins	(CS152)

The table is not in 1NF because of the multi-valued attribute Course_code. The decomposition of the table into 1NF is shown below:

Instructor's name	Course code
Prof. George	CS101
Prof. George	CS154
Prof. Atkins	CS152

Second Normal Form (2NF)

1. The table should be in the first normal form.
2. The primary key of the table should compose exactly 1 column.

Student name	Course code
Rahul	CS152
Rajat	CS101
Rahul	CS154
Raman	CS101

As per the second normal form definition, our enrollment table above isn't in the second normal form. To achieve the same (1NF to 2NF), we can rather break it into 2 tables:

Students:

Student name	Enrolment number
Rahul	1
Rajat	2
Raman	3

The second column is unique and it indicates the enrollment number for the student. Clearly, the enrollment number is unique. Now, we can attach each of these enrollment numbers with course codes.

Third Normal Form:

In the third normal form, the following conditions are required:

- The table should be in the second normal form.
- There should not be any functional dependency.

Course code	Course venue	Instructor's name	Department
MA214	Lecture Hall 18	Prof. Ronald	Mathematics Department
ME112	Auditorium building	Prof. John	Electronics Department

Third normal incorporates functional dependency by decomposing the table into 2 separate tables:

Course code	Course venue	Instructor's ID
MA214	Lecture Hall 18	1
ME112	Auditorium building,	2

Here, the third column is the ID of the professor who's taking the course.

Instructor's ID	Instructor's Name	Department
1	Prof. Ronald	Mathematics Department
2	Prof. John	Electronics Department

Boyce-Codd Normal Form (BCNF):

Boyce-Codd Normal form is a stronger generalization of third normal form. A table is in Boyce-Codd Normal form if and only if at least one of the following conditions are met for each functional dependency $A \rightarrow B$:

- A is a superkey.
- It is a trivial functional dependency.

Fourth normal form:

A table is said to be in fourth normal form if there is no two or more, independent and multi valued data describing the relevant entity.

Fifth normal form:

A table is in fifth Normal Form if:

- It is in fourth normal form.
- It cannot be subdivided into any smaller tables without losing some form of information.

Questions:

1. Normalize the following table to 1NF

Roll_no	Name	Subject
101	Akon	OS, CN
103	Bkon	Java
102	Ckon	C, C++

```
SQL> select * from table_1NF_URK21CS1128;

   ROLL_NO NAME    SUBJECT
---------- ------- ----------
       101 ARS     OS
       101 ARS     CN
       102 CDP     Java
       103 BJJ     C
       103 BJJ     C++
```

2. Normalize the following 'Student' table to 1NF

ID	Name	Mobile_number
1	ABC DEF GHI	12345678, 87654321
2	JKL MNO PQR	11223344
3	RST UVW XYW	21436587, 78563412

```
SQL> select * from student_1NF_URK21CS1128;

        ID NAME                 MOBILE
---------- -------------------- ------------------------
         1 ABC                  12345678
         1 ABC                  87654321
         1 DEF                  87654321
         1 GHI                  87654321
         1 GHI                  12345678
         1 DEF                  12345678
```

3.Normalize the following table to 2NF

Student_ID	Course_ID	Course_Fee
1	IOT	750
2	IOT	750
3	IOT	750
1	AI	880
2	AI	880
3	AI	880

```
SQL> select * from student_2NF_URK21CS1128;

STUDENT_ID COUR
---------- ----
         1 IOT
         2 IOT
         3 IOT
         1 AI
         2 AI
         3 AI

6 rows selected.

SQL> select * from course_2NF_URK21CS1128;

COUR COURSE_FEE
---- ----------
IOT         750
AI          800
```

4.Normalize the following table to 2NF

Teacher_ID	Subject	Teacher_age
25	Chemistry	30
25	Biology	30
47	English	35
83	Maths	38
83	Computer	38

```
SQL> select * from subject_2NF_URK21CS1128;

TEACHER_ID SUBJECT
---------- --------------
        25 Chemistry
        25 Biology
        47 English
        83 Maths
        83 Computer

SQL> select * from teacher_URK21CS1128;

TEACHER_ID SUBJECT               AGE
---------- -------------- ----------
        25 Chemistry              30
        25 Biology                30
        47 English                35
        83 Maths                  38
        83 Computer               38
```

5.Normalize the following table to 3NF

SID	CID	S_name	C_name	Grade	Faculty	F_phone
1	IS318	Adams	Database	A	Howser	60192
1	IS301	Adams	Program	B	Langley	45869
2	IS318	Jones	Database	A	Howser	60192
3	IS318	Smith	Database	B	Howser	60192
4	IS301	Baker	Program	A	Langley	45869
4	IS318	Baker	Database	B	Howser	60192

```
SQL> select * from cid_3NF_URK21CS1128;

CID   C_NAME
----- ------------
IS318 Database
IS301 Program

SQL> select * from sid_3NF_URK21CS1128;

       SID S_NAME
---------- ----------
         1 Adams
         2 Jones
         3 Smith
         4 Baker

SQL> select * from grade_URK21CS1128;

       SID CID    S_NAME     C_NAME       GR FACULTY            F_PHONE
---------- ------ ---------- ------------ -- --------------- ----------
         1 IS318  Adams      Database     A  Howser                60192
         1 IS301  Adams      Program      B  Langley               45869
         2 IS318  Jones      Database     A  Howser                60192
         3 IS318  Smith      Database     B  Howser                60192
         4 IS301  Baker      Program      A  Langely               45869
         4 IS318  Baker      Database     B  Howser                60192

6 rows selected.
```

```
SQL> select * from faculty_3NF_URK21CS1128;

CID    FACULTY            F_PHONE
------ --------------- ----------
IS318  Howser                60192
IS301  Langely               45869
```

6.Normalize the following table to 3NF

Emp_ID	Emp_name	Project_ID	Project_name
1	ABC	123	X
2	DEF	789	Z
3	GHI	123	X
4	JKL	123	X
5	MNO	789	Z
6	PQR	789	Z
7	STU	123	X

```
SQL> select * from emp_pro_3NF_URK21CS1128;

    EMP_ID PROJECT_ID P
---------- ---------- -
         1        123 X
         2        789 Z
         3        123 X
         4        123 X
         5        789 Z
         6        789 Z
         7        123 X

7 rows selected.

SQL> select * from employee_3NF_URK21CS1128;

    EMP_ID EMP
---------- ---
         1 ABC
         2 DEF
         3 GHI
         4 JKL
         5 MNO
         6 PQR
         7 STU

7 rows selected.

SQL> select * from project_3NF_URK21CS1128;

PROJECT_ID P
---------- -
       123 X
       789 Z
```

7.Normalize the following table to BCNF

OID	O_Date	CID	C_Name	C_State	PID	P_Desc	P_Price	Qty
1006	10/24/09	2	Apex	NC	7	Table	800	1
1006	10/24/09	2	Apex	NC	5	Desk	325	1
1006	10/24/09	2	Apex	NC	4	Chair	200	5
1007	10/25/09	6	Acme	GA	11	Dresser	500	4
1007	10/25/09	6	Acme	GA	4	Chair	200	6

```
SQL> select * from order_URK21CS1128;

       OID O_DATE           CID C_NAME   C_         PID P_DESC      P_PRICE QT
---------- -------- ---------- -------- -- ---------- -------- ---------- --
      1006 10/24/09           2 Apex     NC           7 Table           800 1
      1006 10/24/09           2 Apex     NC           4 Chair           200 5
      1006 10/24/09           2 Apex     NC           5 Desk            325 1
      1007 10/25/09           6 Acme     GA          11 Dresser         500 4
      1007 10/25/09           6 Acme     GA           4 Chair           200 6
```

```
SQL> select * from id_BCNF_URK21CS1128;

       OID        CID        PID
---------- ---------- ----------
        10          1         27
        10          5         25
        10         11         22
        14          2         26
        14          4         21

SQL> select * from order_URK21CS1128;

       OID O_DATE           CID C_NAME   C_         PID P_DESC      P_PRICE QT
---------- -------- ---------- -------- -- ---------- -------- ---------- --
      1006 10/24/09           2 Apex     NC           7 Table           800 1
      1006 10/24/09           2 Apex     NC           4 Chair           200 5
      1006 10/24/09           2 Apex     NC           5 Desk            325 1
      1007 10/25/09           6 Acme     GA          11 Dresser         500 4
      1007 10/25/09           6 Acme     GA           4 Chair           200 6


SQL> select * from order_BCNF_URK21CS1128;

       OID O_DATE
---------- --------
      1006 10/24/09
      1007 10/25/09

SQL> select * from  product_BCNF_URK21CS1128;

       PID P_DESC    P_PRICE        QTY
---------- ------ ---------- ----------
         7 Table         800          1
         5 Desk          325          1
         4 Chair         200          5
        11 dreser        500          4
         4 chair         200          6

SQL> select * from customer_BCNF_URK21CS1128
  2  ;

       CID C_NAME   C_
---------- -------- --
         2 Apex     NC
         6 Acme     GA

SQL>
```

8.Normalize the following table to BCNF

DID	Dname	EID	Ename	PID	Pname	Btime
10	Finance	1	Huey	27	Alpha	4.5
10	Finance	5	Dewey	25	Beta	3
10	Finance	11	Louie	22	Gamma	7
14	R&D	2	Jack	26	Pail	8
14	R&D	4	Jill	21	Hill	9

```
SQL> select * from dep_BCNF_URK21CS1128;

       DID        EID        PID
---------- ---------- ----------
        10          1         27
        10          5         25
        10         11         22
        14          2         26
        14          4         21

SQL> select * from p_BCNF_URK21CS1128;

       PID PNAME          BTIME
---------- --------- ----------
        27 Alpha            4.5
        25 Beta               3
        22 Gamma              7
        26 Pail               8
        21 Hil                9

SQL> select * from e_BCNF_URK21CS1128;

       EID ENAME
---------- ------------
         1 Huey
         5 Dewey
        11 Louie
         2 Jack
         4 Jill
```

9.Normalize the following table to 4NF

Stu_ID	Course	Hobby
21	Computer	Dancing
21	Maths	Singing
34	Chemistry	Dancing
74	Biology	Cricket
59	Physics	Hockey

```
SQL> select * from hobby_4NF_URK21CS1128;

    STU_ID HOBBY
---------- ------------
        21 Dancing
        34 Singing
        74 Cricket
        59 Hockey

SQL> select * from student_4NF_URK21CS1128;

    STU_ID COURSE
---------- ------------
        21 Computer
        21 Maths
        34 Chemistry
        74 Biology
        59 Physics
```

10.Normalize the following table to 5NF

Agent	Company	Product
A1	PQR	Nut
A1	PQR	Bolt
A1	XYZ	Nut
A1	XYZ	Bolt
A2	PQR	Nut

```
SQL> select * from agent_5NF_URK21CS1128;

AGE COMP
--- ----
A2  PQR
A1  PQR
A1  XYZ

SQL> select * from company_5NF_URK21CS1128;

AGEN COMP
---- ----
A1   PQR
A1   XYZ
A2   PQR

SQL> select * from product_5NF_URK21CS1128;

COMP PROD
---- ----
PQR  Nut
PQR  Bolt
XYZ  Nut
XYZ  Bolt
```

Result:

All the questions are executed using Database Normalization method successfully and each showed the valid output.